Fishery Survey – Amnicon Lake
Douglas County, 2006-2007
WBIC Code – 2858100

Scott Toshner
Senior Fisheries Biologist
Wisconsin Department of Natural Resources
Northern Region – Brule
April, 2010

Executive Summary

A fisheries survey was conducted on Amnicon Lake, Douglas County in 2006-2007 to determine the status of fish species. Amnicon Lake has supported and continues to support a diverse fish community and popular sport fishery. Good to excellent natural reproduction supports all species. Harvest management aimed at maintaining self-sustaining stocks has been largely successful.

Adult walleye abundance was 2.8 fish/acre, slightly below the Bayfield and Douglas County average for naturally reproducing walleye lakes of 3.7 fish/acre. Angler exploitation of walleye on Amnicon Lake was low (1% for both the 1999 and 2006 survey years). No tribal spearing occurred during 2006.

Muskellunge were the most sought after gamefish in Amnicon Lake. Muskellunge abundance in 2006-2007 was high (1.12 fish/acre $\geq$ 30 in) and an increase from abundances in 1992 (0.92 fish/acre $\geq$ 30 in) and 1997 (0.46 fish/acre $\geq$ 30 in). In comparison with other muskellunge waters in northern Wisconsin, Amnicon Lake is at the high end of the reported range for muskellunge density. Amnicon Lake is considered by muskellunge anglers to be an action lake and rightfully so, with catch rates of 9.0 and 9.3 hours/fish in 1999 and 2006, the average catch rate statewide is 35 hours/fish. In recent years (1992, 1997 and 2006) the muskellunge size structure in Amnicon Lake has not changed significantly and was dominated by fish < 38 inches long.

Black crappie was the most sought after and harvested panfish by anglers in 2006 with 25% of the directed effort and an estimated harvest of 2,264. The decline of the size structure of harvested black crappie may be a sign of recruitment overfishing, however, since abundance has

remained similar and estimated catch has increased it is unlikely angler harvest has been depleting abundance.

Management recommendations for Amnicon Lake include: 1) Maintain walleye abundance in Amnicon Lake at 3.2 adults/acre, 2) Retain current muskellunge regulation since recruitment overfishing does not appear to be affecting size structure and abundance, 3) Track recent introduction of northern pike and their effect on the fish community, 4) Explore aging analysis of muskellunge as funding and future workload permits, and 5) Work with local residents, the Amnicon/Dowling Lake Management District, the Douglas County Land and Water Conservation Department and the WDNR lake grants program to revisit the lake management plan to ensure management objectives are being met.

Introduction

Amnicon Lake is a 426 acre drainage lake near the headwaters of the Amnicon River. The Amnicon River begins above Dowling Lake then flows into Amnicon Lake prior to entering Lyman Lake. The Amnicon River watershed is located in north central Douglas County and flows into Lake Superior. Maximum depth of Amnicon Lake is 31 feet with only 4% of the lake area over 20 feet in depth and an alkalinity of 24 mg/L. The lake has a highly developed shoreline with the exception of 1 mile of shore that consists of three islands under public ownership as State of Wisconsin lands. Amnicon Lake is tear drop shaped with a relatively non-convoluted shoreline and a total shoreline length (including islands) of 6 miles. Public access is provided at one developed site owned by the Town of Summit located on the northwest side of the lake. In addition to this developed access site, there are also two undeveloped platted access sites (Johannes and Sather, 1972).

Water quality measurements taken on Amnicon Lake indicate mid to high levels of nutrients. Average summer secchi disk depth, total phosphorus and chlorophyll-a trophic state index (TSI) values for the deep hole on Amnicon Lake were 51.6 (SD = 3.11, N = 83), 51.4 (SD = 2.14, N = 49) and 50.4 (SD = 5.26, N = 45) for the time period between 1974 and 2009. TSI is an index for evaluating trophic state or nutrient condition of lakes (Carlson 1977 and Lillie et. al. 1993). TSI values can be computed for water clarity (secchi disk measurements), chlorophyll-a, and total phosphorus values. TSI values represent a continuum ranging from very clear, nutrient poor water (low TSIs) to extremely productive, nutrient rich water (high TSIs). The data on Amnicon Lake indicate the nutrient condition was mesotrophic to eutrophic (medium to high productivity) when considering secchi disk, total phosphorus and chlorophyll-a TSI indices. Some care should be taken in the interpretation of TSI productivity values, since Amnicon Lake

is considered dystrophic due to its tannin stained water. Dystrophic lakes can mask true productivity levels due to stained water limiting algal growth.

Amnicon Lake has a diverse fishery consisting of walleye *Sander vitreus*, muskellunge *Esox masquinongy*, northern pike *E. lucius*, largemouth bass *Micropterus salmoides*, bluegill *Lepomis macrochirus*, pumpkinseed *L. gibbosus*, rock bass *Ambloplites rupestris*, black crappie *Pomoxis nigromaculatus*, yellow perch *Perca flavescens*, white sucker *Catostomus commersoni*, yellow bullhead *Ictalurus natalis*, black bullhead *I. melas*, trout perch *Percopsis omiscomayus*, creek chub *Semotilus atromaculatus*, tadpole madtom *Noturus gyrinus*, brook stickleback *Culaea inconstans*, johnny darter *Etheostoma nigrum*, Iowa darter *E. exile*, central mudminnow *Umbra limi*, common shiner *Notropis cornutlus* and golden shiner *Notemigonus crysoleucas*.

Historic fisheries management of Amnicon Lake has included surveys, stocking, and various length and bag regulations. A historic survey for walleye occurred in 1999 utilizing Wisconsin Department of Natural Resources (WDNR) standardized treaty protocols (Hennessey 2002). An additional walleye survey estimating adult population was conducted by the Great Lakes Indian Fish and Wildlife Commission (GLFWC) in 1991 using a different sampling protocol i.e., electroshocking to both mark and recapture walleye. Historic surveys for muskellunge occurred in 1992 and 1997 using methods described in Margenau and AveLallemant (2000). A muskellunge spawning operation in 1962 provides additional historical abundance and length frequency data. Basic fishery surveys utilizing a variety of gear types were conducted by WDNR in 1947, 1955, 1966 and 2005. Fall electroshocking surveys were utilized to assess recruitment of walleye in 1989, 1990, 1991, 1992 and 2005.

Amnicon Lake has a long stocking history and has been stocked with a number of fish species, including walleye, muskellunge, largemouth bass, bluegill and crappie, since at least

1934 (Table 1). Nearly annual walleye and muskellunge stocking occurred from at least 1933 to 1965, when over 8,940,000 fry and over 84,500 small fingerlings walleye were stocked and 890,000 fry and 17,500 fingerling muskellunge were stocked into Amnicon Lake. Walleye and muskellunge stocking was recommended to continue based on a 1947 fishery survey which found good size and age distribution of walleye and only one muskellunge (Wilder and Fischthal 1947). This same report recommended encouragement of extensive angling to crop what was believed to be an overabundant crappie population. A basic inventory of the Amnicon Lake fishery in 1966 found that walleye stocking was unnecessary because little correlation was found between years when walleye were stocked and the size of that particular year class also if walleye stocking were to be considered in the future larger size fingerling were recommended (Weiher 1968). Muskellunge stocking was recommended to continue due to results of the survey in 1966 which found that of the twelve muskellunge captured three had finclips which indicated they were of hatchery origin. Stocking of predominately large fingerling muskellunge continued on a nearly annual basis from 1966 until 1997 when abundance of muskellunge was found to be high (Margenau and AveLallemant 2000). Walleye stocking from 2002 to 2007 was the result of fry "plant backs" due to eggs being taken from Amincon Lake walleye for stocking in other Lake Superior basin lakes in Wisconsin.

Fishing regulations have been managed via statewide length and bag limits over time on Amnicon Lake. There was no minimum length limit for walleye until 1990 when a 15 in minimum length limit was instituted statewide. Bag limits for walleye have been adjusted annually according to tribal harvest declarations that began in 1991. Largemouth and smallmouth bass regulations have also changed over time. In 1989, a northern bass zone was

created with an opening of the harvest of bass starting the 3rd Saturday in June with a 12 in minimum length limit. In 1998, the minimum length limit for bass was increased to 14 in.

Recent management has focused on fishery surveys and acquiring walleye eggs and milt to provide Lake Superior strain walleye to the propagation system. In addition, a critical habitat designation survey was begun in the summer of 2009. The objective of the 2006-2007 survey was to determine the status of the walleye, muskellunge and largemouth bass populations, along with sport and tribal use of these species. More specifically, we were interested in determining population abundance, growth, size structure and harvest of walleye, muskellunge and largemouth bass.

Methods

Amnicon Lake was sampled during 2006-2007 following the Wisconsin Department of Natural Resources comprehensive treaty assessment protocol (Hennessey 2002). This sampling included spring fyke netting and electroshocking to estimate walleye, spring fyke netting in 2006 and spring fyke netting in 2007 to estimate muskellunge abundance, fall electroshocking to estimate year class strength of walleye young-of-the-year (YOY), and a creel survey (both open water and ice).

Walleye were captured for marking in the spring shortly after ice out with fyke nets. Each fish was measured (total length TL; inches and tenths) and fin-clipped. Adult (mature) walleyes were defined as all fish for which sex could be determined and all fish 15 in or longer. Adult walleyes were given a lake-specific mark. Walleyes of unknown sex less than 15 inches in length were classified as juveniles (immature) and were marked with a different lake-specific fin clip. Marking effort was based on a goal for total marks of 10% of the anticipated spawning population estimate. To estimate adult abundance, walleyes were recaptured 1-2 days after

netting. Because the interval between marking and recapture was short, electroshocking of the entire shoreline was conducted to ensure equal vulnerability of marked and unmarked walleyes to capture. All walleyes in the recapture run were measured and examined for marks. All unmarked walleyes were given the appropriate mark so that total abundance could be estimated. To estimate total walleye abundance, a second electroshocking recapture run was conducted 2 weeks after the first recapture run. Again, the entire shoreline of the lake was electroshocked. Population estimates were calculated with the Chapman modification of the Petersen Estimator using the equation:

$$N = \frac{(M+1)(C+1)}{(R+1)}$$

where N is the population estimate, M is the total number of marked fish in the lake, C is the total number of fish captured in the recapture sample, and R is the total number of marked fish captured. The Chapman Modification method is used because simple Petersen Estimates tend to overestimate population sizes when R is relatively small (Ricker 1975). Abundance and variance were estimated by the total for walleye that were $\geqslant$ 15 in and sexable.

Muskellunge population estimates were conducted over a two-year period, with marking in year-1 and recapture in year-2. In year-1, muskellunge were marked during fyke netting and electroshocking efforts throughout the sampling season. All muskellunge 30 in and larger were given the adult clip for the lake (the same adult clip given to walleye and bass). Unknown sex fish less than 30 in long were given an alternate fin clip. In year-2 muskellunge were recaptured using fyke nets in Late April. Adult muskellunge population abundance and variance were estimated by total for muskellunge that were $\geqslant$ 30 in and sexable using the Chapman-Petersen estimator, with the following adjustment in the equation:

$$N = \frac{M(C+1)}{(R+1)}$$

Sexable muskellunge captured during fyke netting in the marking survey were used to calculate relative abundance. Length frequency proportions were developed using adult fish and unknown sex fish that were equal or greater than the size of the smallest female identified or over 30 inches in the marking run fyke nets and supplemental electroshocking, if utilized in that years survey. Length distributions were summarized using relative stock density (RSD; Anderson and Gutreuter 1983), where 30 in was stock size (Hanson 1986).

Largemouth bass sampled during the second spring electroshocking runs were used to determine relative abundance and length frequency. The entire shoreline of the lake (6 miles) was sampled. All surveys occurred in May.

Walleye age and growth were determined from dorsal spine cross sections viewed microscopically at 100X (Margenau 1982). Age and growth of other fish species were determined by viewing acetate scale impressions under a 30X microfilm projector. Growth rates for all species were compared to an 18 county regional mean (Northern Region) using the Fisheries and Habitat database. Size structure quality of species sampled was determined using the indices proportional (PSD) and relative (RSD) stock densities (Anderson and Gutreuter 1983). The PSD and RSD value for a species is the number of fish of a specified length and longer divided by the number of fish of stock length or longer, the result multiplied by 100 (Appendix Table 1). Changes in population size structure and differences between the size structure of angler and tribal harvest were determined using Kolmogorov-Smirnov tests.

Survey data was also collected to estimate abundance and angler catch information on other species such as bass, northern pike, and panfish. Panfish population data were collected in the spring fyke-netting period 1992, 1999 and 2006. Panfish were identified to species and

measured for TL. Traditional survey periods for panfish are most often at warmer water temperatures and related to observed spawning locations. In addition, the sampling protocol did not include panfish targeted fyke netting. Therefore the data gathered may not best represent panfish populations.

Creel surveys used a random stratified roving access design (Beard et al. 1997; Rasmussen et al. 1998). The survey was stratified by month and day-type (weekend / holiday or weekday), and the creel clerk conducted interviews at random within these strata. The survey was conducted on all weekends and holidays, and a randomly chosen two or three weekdays. Only completed-trip interview information was used in the analysis. The clerk recorded effort, catch, harvest, and targeted species from anglers completing their fishing trip. The clerk also measured harvested fish and examined them for fin-clips. Angler exploitation of adult walleye was estimated by dividing the projected number of fin-clipped walleye harvested during the course of the fishing season by the total number of marked walleye at large (Beard et al. 2003).

Results

Total survey effort in 2006 included 41 fyke net lifts targeting spawning gamefish. Four electroshocking surveys of the entire shoreline totaling 6.0 hours in spring (first and second recapture surveys and supplemental muskellunge marking survey) and 1.9 hours in fall (walleye recruitment survey) were conducted. Total survey effort in 2007 included 27 net lifts for the recapture of muskellunge.

Walleye. Adult walleye abundance ($\geqslant$ 15 in and sexable fish) was 1,210 (CV = 0.08, 2.8 adults/acre) in 2006 for Amnicon Lake. Adult walleye abundance in Amnicon Lake increased from 1991 to 1999 and then decreased in 2006. The average of the three walleye abundances

over the 3 sampling events was 3.2 fish/acre (Figure 1).

Walleye size structure decreased since 1991. Percent length frequency suggests there was an increase in the proportion of walleye in the 10 to 14.0 in group and a decrease of walleye in the 15 in group and greater in 1999 and 2006 compared to 1991 (Figure 2). Length of walleye captured during electroshocking in 1991 differed significantly from 1999 and 2006 and suggests a trend of declining size structure (1991 vs. 1999, $D = 0.51$, $P < 0.001$; 1991 vs. 2006, $D = 0.51$, $P < 0.001$; 1999 vs. 2006, $D = 0.08$, $P = 0.0535$). Mean length for sexable walleye increased then decreased from 15.4 in (SD = 2.57, N = 514), 13.7 in (SD = 3.90, N = 550) to 14.2 in (SD = 4.15, N = 573) in for survey years 1991, 1999 and 2006. Proportional stock density (PSD) increased then decreased from 54, 20, to 28 during the same time period, while RSD-20 increased from 4, 11, to 16. Interestingly, these findings suggest that while the overall walleye size structure has decreased the proportion of larger walleye ($\geq$ 20 in) has actually increased.

Age of adult walleye sampled during the 2006 survey ranged from III to XVI. Male and female walleye first reached maturity at III. Age III and V walleye accounted for 62% of the adult stock in 2006 in contrast to 1999 in which age IV and V walleye accounted for 67% of the adult stock (Figure 3). Growth rates for both sexes were relatively consistent. In 1999 and 2006 growth rates were below regional averages (Figure 4), while growth was dimorphic, male and female walleye reaching 14 in sometime during the fourth and sixth growing season, respectively.

Walleye natural reproduction in Amnicon Lake has remained low. Relative abundance of young-of-year (YOY) walleye in Amnicon Lake in 2006 was 0.17 fish/mile (0.53 fish/hour). The average walleye YOY/mile was 0.8 (SD = 1.66, N = 6) for surveys completed from 1989 to 2006 by both WDNR and GLIFWC. Fingerling relative abundance has been variable and low

from 1989 to 2006 with a range of 0 fish/mile to 4.2 fish/mile (Figure 5). Mean relative abundance of YOY walleye for naturally reproducing and stocked walleye lakes surveyed by WDNR in Bayfield and Douglas Counties from 1991 to 2007 was 28.2 fish/mile (SD = 57.35, N = 73) and 10.4 fish/mile (SD = 18.54, N = 41), respectively (Figure 5).

Muskellunge. Muskellunge abundance in Amnicon Lake was high. Adult muskellunge abundance ($\geq$ 30 in) was 477 (CV = 18.1; 1.1 fish/acre) in 2006. Previous density estimates were 0.9 fish/acre in 1992 and 0.5 fish/acre in 1997 (Figure 6). Catch per unit effort (CPUE; the number of muskellunge caught with each fyke net lift) decreased from 3.6 to 3.5, to 1.8 from 1992 to 1997 to 2006.

In recent years (1992, 1997 and 2006) the muskellunge size structure in Amnicon Lake has not changed significantly, however all years were significantly different from 1962 (1992 vs 1997, D = 0.90, P =0.81; 1997 vs 2006, D = 0.13, P = 0.29; 1992 vs 2006, D= 0.07, P = 1.00; 1962 vs. 1992, D = 0.50, P < 0.001; 1962 vs. 1997, D = 0.50, P < 0.001; 1962 vs. 2006, D = 0.50, P < 0.001; Figure 7). The average length of muskellunge in Amnicon Lake remained similar during all survey periods and was 31.5 (SD = 3.3, N = 112), 31.3 (SD = 3.2, N = 116) to 31.7 (SD = 3.2, N = 113) inches for survey years 1992, 1997 and 2006. Average length of muskellunge in 1962 was 28.3 (SD = 5.9, N = 158) lower than recent values. The RSD-34 was 32, 21 and 33 in the three survey periods, 1992, 1997 and 2006. RSD-40 was 1, 2 and 1 in the three survey periods. In contrast to mean length, the 1962 RSD-34 and RSD-40 values were higher than recent values and were 70 and 30, respectively. In comparison, 7 reference lakes from Margenau and Aveallemant (2000) with the same angling regulation as Amnicon Lake (34 in minimum) had an RSD-34 average of 62 (SD = 15.1, N = 14) and an RSD-40 average of 14 (SD = 12.6, N = 14) from 1988 to 1997.

Muskellunge relative weight (Wr) in Amnicon Lake averaged 83 (SD = 7.7, N = 95) in 2006. This was less than a mean Wr of 93 reported by Neumann and Willis (1994) for eleven Wisconsin muskellunge populations in the length range of 30-38 inches.

Largemouth Bass. Numbers of largemouth bass in Amnicon Lake have increased since previous surveys. Largemouth bass relative abundance in Amnicon Lake was 38.5 fish/mile in 2006. Relative abundance of largemouth bass increased since 1992 (20.0 fish/mile) and 1999 (12.1 fish/mile). Size structure of largemouth bass for the 2006 survey was fair with a mean length of 11.7 in (SD = 2.28; N = 77) and PSD and RSD-15 values of 36 and 13, respectively. Historic size structure has remained similar for largemouth bass. PSD values were 39 and 59 and RSD-15 values were 4 and 15 for 1992 and 1999, respectively.

Northern Pike. Northern pike were captured in a survey in 2006 and 2007. One female 30.8 in northern pike was captured in fyke nets in 2006 and two females (30.0 and 34.4 in) and one male (27.3 in) were captured in fyke nets in 2007. These were the first northern pike captured in a fishery survey on Amnicon Lake and document the addition of a new species to the lake.

Panfish. Sampling of major panfish species indicated a generally poor size structure. Yellow perch were the most abundant panfish species sampled in Amnicon Lake in 2006 (N = 5,051) as well as in surveys completed in 1992 (N = 933) and 1999 (N = 1,091). Relative abundance of yellow perch has increased by fivefold and mean length remained similar over time. PSD and RSD-10 for yellow perch indicate a poor size structure for all sampling periods (Table 2).

Bluegill were the second most abundant panfish species sampled in 2006 (N = 2,084). Relative abundance of bluegill remained similar from 1992 to 1999 and like yellow perch

increased fivefold in the most recent survey. Mean length has declined overtime and PSD and RSD-8 indicate a poor size structure for all sampling periods (Table 2).

Black crappie were the third most abundant panfish species sampled in 2006 (N = 222). Relative abundance of black crappies has remained similar during all sampling periods. Mean length and PSD and RSD-10 indicate a decline in size structure. Size structure in 1992 was good (PSD = 75, RSD-10 = 8), in 2002 size structure was considered poor (PSD = 25, RSD-10 = 1; Table 2).

Sport and Tribal Fishery. Anglers fished an estimated 11,054 hours (25.9 hrs/acre) during the 2006-2007 season on Amnicon Lake, which is near the average of 22.5 hrs/acre (SD = 9.56, N = 40) for Bayfield and Douglas County walleye lakes from 1990 to 2007 (WDNR unpublished data, Brule field office) and below the Northern Wisconsin Region (20 counties) average from 1990 to 2007 of 33.3 hrs/acre (SD = 24.6, N = 407). Open water anglers accounted for 71% of all fishing effort. The directed effort i.e., effort targeted toward a specific fish, was highest for muskellunge (25.2%), followed by walleye (12.6%) and largemouth bass (11.8%). The most sought after panfish species was black crappie, with 24.8% of the directed effort. Fishing pressure has remained fairly consistent since 1999. The fishing pressure (hrs/acre) was 28.6 and 25.9 for 1999 and 2006, respectively.

Angler exploitation of walleye was low remaining at 1% in both 1999 and 2006. An estimated 226 walleye were caught by anglers in the open water and ice season of 2006 compared to 508 in 1999. Anglers harvested an estimated 50 walleye in 1999 and 21 walleye in 2006. In 2006, average length of angler harvested walleye was 18.0 in (SD = 2.92, N = 7), which was an increase from 16.7 (SD = 2.82, N = 15) in in 1999.

Tribal harvest did not occur in 2006. Tribal harvest has occurred in 4 years from 1991 to 2006. The average number of walleye tribally harvested per year when spearing occurred on Amnicon Lake was 81 fish/year. Since tribal harvest did not occur in years when walleye population estimates were completed, tribal exploitation can not be calculated. Total exploitation (angler plus tribal exploitation) was 1% in 2006.

Estimated harvest in 2006 was low for all gamefish species in Amnicon Lake. The second and third highest estimated harvests in 2006 were for muskellunge (harvest = 9) and largemouth bass (harvest = 8). Estimated harvest in 1999 was also low for muskellunge (harvest = 26) and for largemouth (harvest = 8). Estimated catch of muskellunge was 513 in 2006 which was a decrease from 584 in 1999. Estimated catch for largemouth bass was the highest for any gamefish in 2006 (catch = 1,300). Estimated catch has increased for largemouth bass since 1999 from 329. Mean length of harvested muskellunge was 34.4 (SD = 3.27, N = 5) and 36.0 (SD = 1.16, N = 3) in for 1999 and 2006. Mean length of harvested largemouth bass was 14.0 (SD = NA, N = 1) and 15.4 (SD = 0, N = 2) in for 1999 and 2006.

One northern pike was reportedly caught by anglers during the creel survey in 2006. This report generated an estimated catch of 3 northern pike. The 2006 creel survey was the first to report any catch of northern pike.

Anglers pursuing panfish fished an estimated 7,516 hours and accounted for 68% of the total directed angling effort for the 2006-07 open water and winter seasons combined. Estimated catch of black crappie increased slightly from 4,836 in 1999 to 5,289 in 2006 however, harvest decreased by half from 4,407 to 2,264 in the same time period. Average length and length frequency of harvested black crappie decreased from 9.9 (SD = 0, N = 2) in to 8.3 (SD = 0, N = 2) in (Figure 9). Catch and harvest of bluegill remained similar at 2,229 and 83 to 2,951 and 54

from 1999 to 2006. Average length of harvested bluegill increased from 6.0 (SD = 0.87, N = 37) in to 6.6 (SD = 0.83, N = 8) in from 1999 to 2006. Yellow perch and pumpkinseed were third and fourth in catch and harvest among panfish in the 2006 creel survey, respectively. Yellow perch catch increased and harvest decreased from 885 and 196 to 2,097 and 12 from 1999 to 2006. Pumpkinseed catch and harvest increased from 9 and 0 to 1,327 and 3 from 1999 to 2006.

Summary and Discussion

Amnicon Lake has supported and continues to support a diverse fish community and popular sport fishery. Good to excellent natural reproduction supports all species. Harvest management aimed at maintaining self-sustaining stocks has been largely successful.

Results from the 2006-2007 survey suggest that Amnicon Lake walleye abundance (2.8 adult fish/acre) was under the statewide objective for walleye populations (3.0 adult fish/acre). However, the average of the 1991, 1999 and 2006 walleye population estimates have been above the statewide management objective and slightly below the Bayfield and Douglas County average for naturally reproducing walleye lakes of 3.7 fish/acre. Angler exploitation of walleye on Amnicon Lake was low (1% for both the 1999 and 2006 survey years). The reasons for the low angler catch and harvest are unknown. The average angler exploitation for naturally reproducing walleye lakes in Bayfield and Douglas Counties from 1990-2007 was 9% (N = 30, SD = 0.07). Length frequency of walleye has declined but may be a result of inconsistent year class strength since angler and tribal harvest combined have been low or low sample size (3 survey years). Even though young of the year walleye surveys indicated relatively weak year classes in the years surveyed, fairly consistent year classes were evident in the aging data. Growth of walleye was slightly below regional averages.

Muskellunge were the most sought after gamefish in Amnicon Lake. Muskellunge abundance in 2006-2007 was high (1.12 fish/acre > 30 in) and an increase from 1992 (0.92 fish/acre > 30 in) and 1997 (0.46 fish/acre > 30 in). In comparison with other muskellunge waters in northern Wisconsin, Amnicon Lake is at the high end of the reported range. Hanson (1986) found a mean density of 0.33 fish/acre (range 0.16 – 0.61 fish/acre) in eight lakes. Margenau and AveLallemant (2000) found mean densities of 0.42 fish/acre and 0.38 fish/acre for fifteen lakes during two separate sampling periods. Density range during these periods for the fifteen lakes was from 0.05 fish/acre to 0.99 fish/acre. Amnicon Lake is considered by muskellunge anglers to be an action lake and rightfully so, with catch rates of 9.0 and 9.3 hours/fish in 1999 and 2006, the average catch rate statewide is 35 hours/fish.

In recent years (1992, 1997 and 2006) the muskellunge size structure in Amnicon Lake has not changed significantly, however all years were significantly different from 1962 which had a larger size structure. In 2006, muskellunge had RSD-34 and RSD-40 values of 33 and 1, respectively. This compares to the 15 study lakes in northern Wisconsin that had an RSD-34 average of 59 and an RSD-40 average of 13 (Margenau and AveLallemant 2000). The smaller than average size structure could be due to high abundances and relative weight data suggests the condition of muskellunge in 2006 was poor. Aging data was not collected for muskellunge but slow growth may be a contributing factor to small size structure since angler harvest does not seem to be a limiting factor with an estimated angler harvest of 9 fish in 2006.

Due to low angler harvest of muskellunge a potential change in the statewide minimum length regulation for muskellunge to 40 inches would likely be inconsequential. However, if and when the statewide minimum length for muskellunge does change, future monitoring could help to discern if it was effective increasing length frequency. Margenau and AveLallemant (2000)

were not able to show a change in muskellunge abundance or size structure resulting from a 40 inch minimum length regulation, however noted that low density species such as muskellunge likely need to be monitored for longer periods of time (study period was five years) to detect any changes. This recommendation should be considered prior to making any conclusions on a regulation change.

The introduction of northern pike which were previously not found in Amnicon Lake warrants observation over time and indicates that changes to the predator structure are underway. Negative interactions between northern pike and muskellunge populations have been identified and increases in northern pike populations may lead to a decrease in muskellunge populations (Inskip and Magnuson 1983; Nate et al. 2003).

Largemouth bass have increased in abundance overtime and have a fair size structure. Estimated catch by anglers was highest for largemouth bass than for any other gamefish species. However, estimated angler harvest was only 8 fish, which like muskellunge has a high catch and release rate among anglers. High estimated catch and low estimated harvest of largemouth bass is a common occurrence in Bayfield and Douglas Counties. Recently there has been debate about the negative interactions between largemouth bass and walleye. Two issues dominate these discussions: 1) can/will anglers increase harvest to high enough levels to lower largemouth bass abundance and 2) are the increases in abundance of largemouth and decreases in walleye abundance a function of larger environmental impacts such as warmer springs, longer growing seasons and drought? If anglers are unwilling/unable to harvest largemouth bass in great numbers then liberalizing largemouth bass regulation would be ineffective in decreasing largemouth bass abundance. If environmental factors such as earlier springs, longer growing seasons and drought are the driving factor in largemouth and walleye abundance, liberalizing

regulations on largemouth bass may have no effect. Consideration may need to be given to removing the minimum length regulation for largemouth bass to promote more angler harvest. On other area lakes and in conjunction with this effort, walleye minimum lengths should be increased to decrease angler harvest of walleye. On Amnicon Lake it seems increasing walleye minimum length limits would have negligible benefits due to the already minimal angler harvest occurring. In any case, public input from citizens that utilize the Amnicon Lake fishery is needed on this topic. We do not know the public desire in relation to the management of walleye and largemouth bass on Amnicon Lake.

The panfish community, although not targeted in the surveys completed in 2006-2007 or historically, appear to be in fair condition. All panfish species had high abundances and relatively poor size structures. Black crappie was the most sought after and harvested by anglers in 2006 with 25% of the directed effort and an estimated harvest of 2,264. The decline of the size structure of harvested black crappie may be a sign of recruitment overfishing, however, since abundance has remained similar and estimated catch has increased it is unlikely angler harvest has been depleting abundance. The mesotrophic to eutrophic status of Amnicon Lake may be partially responsible for above average abundance of panfish.

Management Recommendations

1. Maintain vigilance of walleye abundance, in 2006 adult walleye abundance was 2.8/acre which was slightly below the statewide management objective for walleye lakes. The average in Amnicon Lake over 3 sampling periods (1991, 1999 and 2006) has been 3.2 adults/acre. Retain the current regulation strategy for walleye.

2. Retain statewide minimum length muskellunge regulation since recruitment overfishing is not affecting size structure and abundance. It is possible in coming years that the statewide minimum length may increase to 40 inches. This increase in minimum length may help to increase length frequency; continued monitoring of the muskellunge population would be needed to discern impacts of the higher minimum length regulation if enacted. In light of the recent introduction of northern pike and potentially eurasian watermilfoil, it will be important to track changes in this top predators population.

3. Explore aging analysis of muskellunge as funding and future workload permits. The lack of age information on muskellunge is problematic and the current population in Amnicon Lake would be ideal for analyzing effect of high abundances on growth rates. Muskellunge cliethrum would be the preferred structure to use for aging which would require the sacrifice of 10 to 12 fish. Other alternatives would include tagging fish to monitor growth rates of individuals.

4. Work with local residents, the Amnicon/Dowling Lake Management District, the Douglas County Land and Water Conservation Department and the WDNR lake grants program to revisit the lake management plan and assess whether the plan is meeting stated objectives. The following lake management plan objectives would be beneficial to the over all health of the lake and the fishery contained within; 1) develop strategies for protecting and enhancing sensitive aquatic and shoreline habitats using the soon to be formalize Critical Habitat Designation findings , 2) formally establish exotic species survey and control programs targeting satellite infestations, 3) provide educational and participation forum for environmentally sensitive shoreline living, 4) identify uses and user groups to facilitate all recreational uses on the lake. Habitat loss, declining shoreline aesthetics, and exotic introductions are warning signs of

cultural disturbances that are degrading ecosystem health. Currently, the exotic Eurasian water milfoil has been identified but not established in Amnicon Lake and much of the developable shoreline has been developed at a high density. These two factors could and have lead to a loss of native habitat. Shoreline restoration projects in areas that are currently lacking buffers should be explored and the addition of woody habitat could help restore habitat loss that has occurred over the decades. Preventing the spread of exotics and enhancing habitat through restoration projects, as well as preserving the existing habitat will be far more beneficial than losing what is currently present and relying on stocking and artificial habitat improvements to maintain the fishery and ecosystem as a whole.

Acknowledgements

I would like to thank Dennis Corbin who was the volunteer for the Self-Help Lake Monitoring Program from 1988 to present, and gathered the water quality data presented in this report. I would also like to thank the biologists and technicians of the Wisconsin Department of Natural Resources who assisted with field collection of data, especially Cris Sand, Marty Kangas, Paul Riordan and Cordell Manz. The WDNR treaty assessment unit, especially Jamison Wendel, Scott Plaster, Todd Brecka and Jill Sunderland for data collection and entry and creel survey data collection, data entry and completion of the creel survey report. With special thanks to Terry Margenau who provided a critical review of the manuscript.

References

Anderson, R. O., and S. J. Gutreuter. 1983. Length, weight, and associated structural indices. Pages 283-300 in L. Nielson and D. Johnson, editors. Fisheries Techniques. American Fisheries Society, Bethesda, Maryland.

Beard, T. D., P. W. Rasmussen, S. Cox, and S. R. Carpenter. 2003. Evaluation of a management system for a mixed walleye spearing and angling fishery in northern Wisconsin. North American Journal of Fisheries Management 23:481-491.

Beard, T. D., Jr., S. W. Hewett, Q. Yang, R. M. King, and S. J. Gilbert. 1997. Prediction of angler catch rates based on walleye population density. North American Journal of Fisheries Management 17: 621-627.

Carlson, R. 1977. A trophic state index for lakes. Limnol. Oceanogr. 22(2):361-69.

Johannes, S. I. and L. M. Sather. 1972. Surface water resources of Douglas County. Department of Natural Resources, Madison WI.

Hanson, D. A. 1986. Population characteristics and angler use of muskellunge in eight northern Wisconsin lakes. American Fisheries Society Special Publication 15:238-248.

Hennessy, J. 2002. Ceded territory fishery assessment report. Wisconsin Department of Natural Resources. Administrative Report 55, Madison.

Inskip, P. D. and J. J. Magnuson. 1983. Changes in fish populations over an 80-year period: Big Pine Lake, Wisconsin. Transactions of the American Fisheries Society 1983; 112: 378-389.

Lillie, R. A., S. Graham, and P. Rassmussen. 1993. Trophic state index equations and regional predictive equations for Wisconsin Lakes. Bureau of Research – Wisconsin Department of Natural Resources, Research Management Findings, Number 35.

Margenau, T. L. and S. P. AveLallemant. 2000. Effects of a 40-inch minimum length limit on muskellunge in Wisconsin. North American Journal of Fisheries Management 20:986-993.

Margenau, T. L. 1982. Modified procedure for aging walleye by dorsal spine sections. Progressive Fish-Culturist 44:204.

Nate, N. A., M. A. Bozek, M. J. Hansen, C. W. Ramm, M. T. Bremigan and S. W. Hewitt. 2003. Predicting the occurrence and success of walleye populations from physical and biological features of northern Wisconsin Lakes. North American Journal of Fisheries Management 2003; 23: 1207-1214.

Neumann, R. M. and D. W. Willis. 1994. Relative weight as a condition index for muskellunge. Journal of Freshwater Ecology 9: 13-18.

Rasmussen, P. W., M. D. Staggs, T. D. Beard, Jr., and S. P. Newman. 1998. Bias and confidence interval coverage of creel survey estimators evaluated by simulation. Transactions of the American Fisheries Society 127: 460-480.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada 191. Department of the Environment, Fisheries, and Marine Science, Ottawa. 382 p.

Weiher, W. 1968. Lake survey of Amnicon Lake, Douglas County. Intra-Department Wisconsin Conservation Department Memorandum. Brule office file.

Wilder, R. E. and J. H. Fischthal. 1947. A biological survey of Amnicon Lake Douglas County, Wisconsin. Section of Fishery Biology Investigational Report No. 624. Wisconsin Conservation Department. Brule office file.

Table 1. Fish Stocking History of Amnicon Lake, Douglas County, Wisconsin.

Year	Species	Number Stocked	Age/Size
1934	Walleye	176,580	Fry
1935	Walleye	110,120	Fry
	Bass (sp?)	920	Unknown
	Muskellunge	40,000	Fry
1936	Walleye	1,640,520	Fry
	Bass (sp?)	1,000	Unknown
	Muskellunge	50,600	Fry
	Bluegill	240	Unknown
	Bullhead (sp?)	2,000	Unknown
	Sunfish (sp?)	240	Unknown
1937	Walleye	366,900	Fry
	Muskellunge	90,900	Fry
	Bluegill	1,000	Adult
	Sunfish (sp?)	1,000	Adult
	Crappie	400	Adult
1938	Walleye	311,928	Fry
	Largemouth Bass	5,952	Small Fingerling
	Walleye	311,928	Fry
	Sunfish (sp?)	18,586	Fingerling
	Perch	2,022	Fingerling
	Crappie	1,501,560	Fry
1939	Walleye	800,000	Fry
	Muskellunge	15	Fingerling
	Muskellunge	200,000	Fry
1940	Walleye	1,300,000	Fry
	Muskellunge	7,000	Fingerling
	Muskellunge	75,000	Fry
	Largemouth Bass	44	Fingerling
	Bluegill	271	Adult
	Bluegill	485	Fingerling
1941	Walleye	500,000	Fry
	Muskellunge	100,000	Fry
1942	Walleye	1,000,000	Fry
	Walleye	4,000	Small Fingerling
	Muskellunge	1,000	Fingerling
1943	Walleye	600,000	Fry
	Walleye	6,100	Fingerling
	Muskellunge	60,000	Fry
	Muskellunge	1,000	Fingerling
1944	Walleye	480,000	Fry
	Walleye	2,400	Fingerling
	Muskellunge	18,000	Fry
1945	Walleye	434,000	Fry
	Walleye	5,800	Fingerling
	Muskellunge	13,575	Fry
1946	Walleye	490,000	Fry
	Walleye	3,000	Small Fingerling
	Muskellunge	23,000	Fry
1947	Walleye	729,000	Fry
	Walleye	1,800	Small Fingerling
	Muskellunge	2,454	Fingerling
1949	Walleye	3,000	Small Fingerling
	Muskellunge	930	Fingerling
1950	Walleye	10,120	Small Fingerling
	Muskellunge	724	Fingerling
1951	Muskellunge	362	Fingerling
1952	Muskellunge	854	Fingerling
1953	Walleye	6,200	Small Fingerling
1954	Walleye	9,431	Small Fingerling
1956	Walleye	6,200	Small Fingerling
1958	Walleye	2,033	Small Fingerling
1959	Muskellunge	507	Fingerling
1960	Walleye	6,200	Small Fingerling
1961	Muskellunge	1,014	Fingerling
1962	Walleye	6,200	Small Fingerling
	Muskellunge	220,000	Fry
1963	Muskellunge	1,014	Fingerling
1964	Walleye	6,200	Small Fingerling
1965	Muskellunge	1,014	Fingerling
1966	Walleye	6,200	Small Fingerling
1967	Muskellunge	315	Fingerling
1968	Muskellunge	300	Fingerling
1969	Muskellunge	315	Fingerling
1970	Muskellunge	500	Fingerling
1971	Muskellunge	800	Fingerling
1972	Muskellunge	415	Fingerling
1973	Muskellunge	423	Fingerling
1974	Muskellunge	826	Fingerling

Table 1(continued). Fish Stocking History of Amnicon Lake, Douglas County, Wisconsin.

Year	Species	Number Stocked	Age/Size
1975	Muskellunge	303	Fingerling
1976	Muskellunge	1,692	Small Fingerling
	Muskellunge	423	Fingerling
1977	Muskellunge	425	Fingerling
1978	Muskellunge	200	Fingerling
1979	Muskellunge	425	Fingerling
1980	Muskellunge	425	Fingerling
1983	Muskellunge	400	Fingerling
1985	Muskellunge	400	Fingerling
1986	Muskellunge	400	Fingerling
1987	Muskellunge	200	Fingerling
1988	Muskellunge	400	Fingerling
1989	Muskellunge	200	Fingerling
1990	Muskellunge	200	Fingerling
1991	Muskellunge	400	Fingerling
1992	Muskellunge	400	Fingerling
1993	Muskellunge	400	Fingerling
1996	Muskellunge	400	Fingerling
1997	Muskellunge	200	Fingerling
2002	Walleye	500,000	Fry
2003	Walleye	300,000	Fry
2005	Walleye	400,000	Fry
2006	Walleye	161,000	Fry
2007	Walleye	125,000	Fry

Table 2. Panfish population metrics, spring fyke netting samples, Amnicon Lake, Douglas County.

Amnicon Lake Panfish					
Yellow Perch					
Year	Number sampled	Fish/net lift	Mean length (in) (SD)	PSD	RSD (10)
1992	933	27.4	5.4 (1.14)	4	0
1999	1,091	35.2	5.4 (0.83)	0	0
2006	5,051	123.2	5.1 (1.04)	0	0
Bluegill					
Year	Number sampled	Fish/net lift	Mean length (in) (SD)	PSD	RSD (8)
1992	393	11.6	5.0 (0.83)	11	0
1999	334	10.8	4.7 (1.01)	10	0
2006	2084	50.8	4.4 (0.73)	2	0
Black Crappie					
Year	Number sampled	Fish/net lift	Mean length (in) (SD)	PSD	RSD (10)
1992	165	4.9	8.5 (1.47)	75	8
1999	304	9.8	7.4 (2.07)	59	10
2006	222	5.4	6.7 (1.60)	25	1

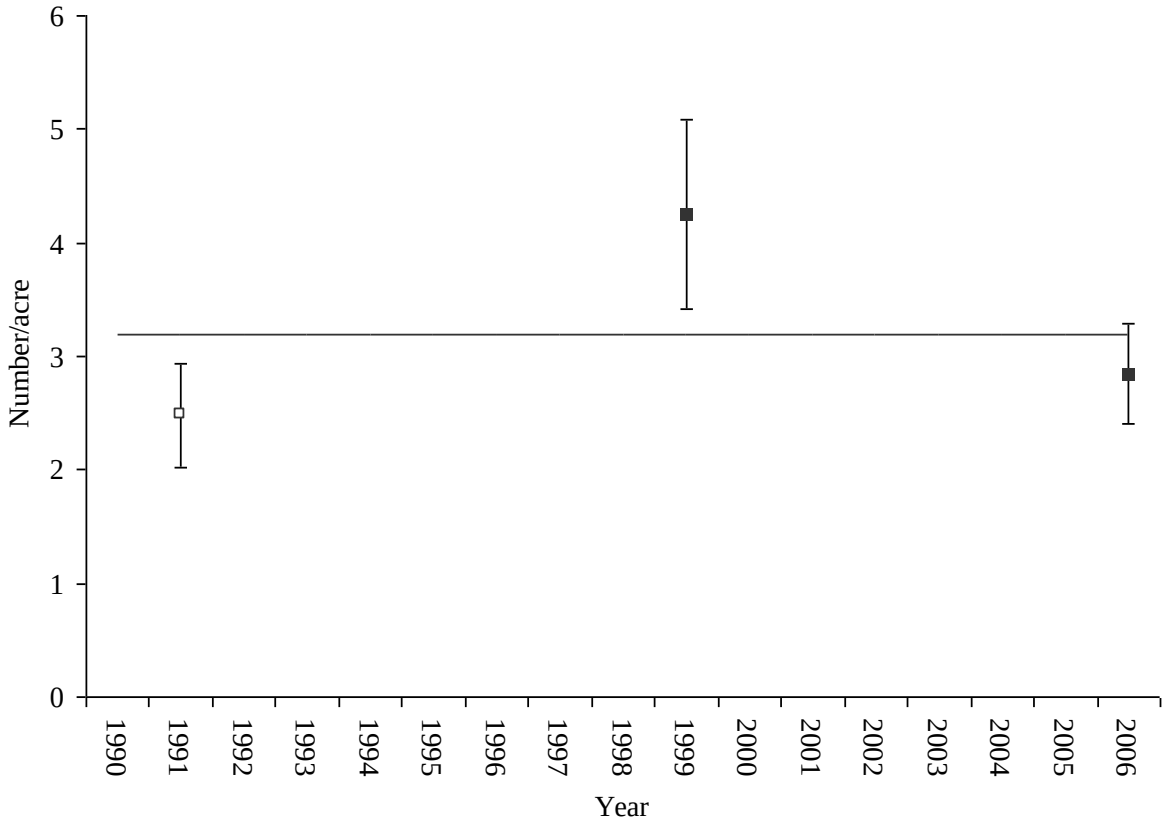

Figure 1. Number of walleye ≥15 in and sexable fish (number/acre ± 95% confidence intervals) by year in Amnicon Lake, Douglas County, Wisconsin. Survey in 1991 utilized electroshocking for both marking and recapture. Surveys in 1999 and 2006 utilized fyke netting for marking and electroshocking for recapture. Horizontal line represents the average of 3.2 fish/acre.

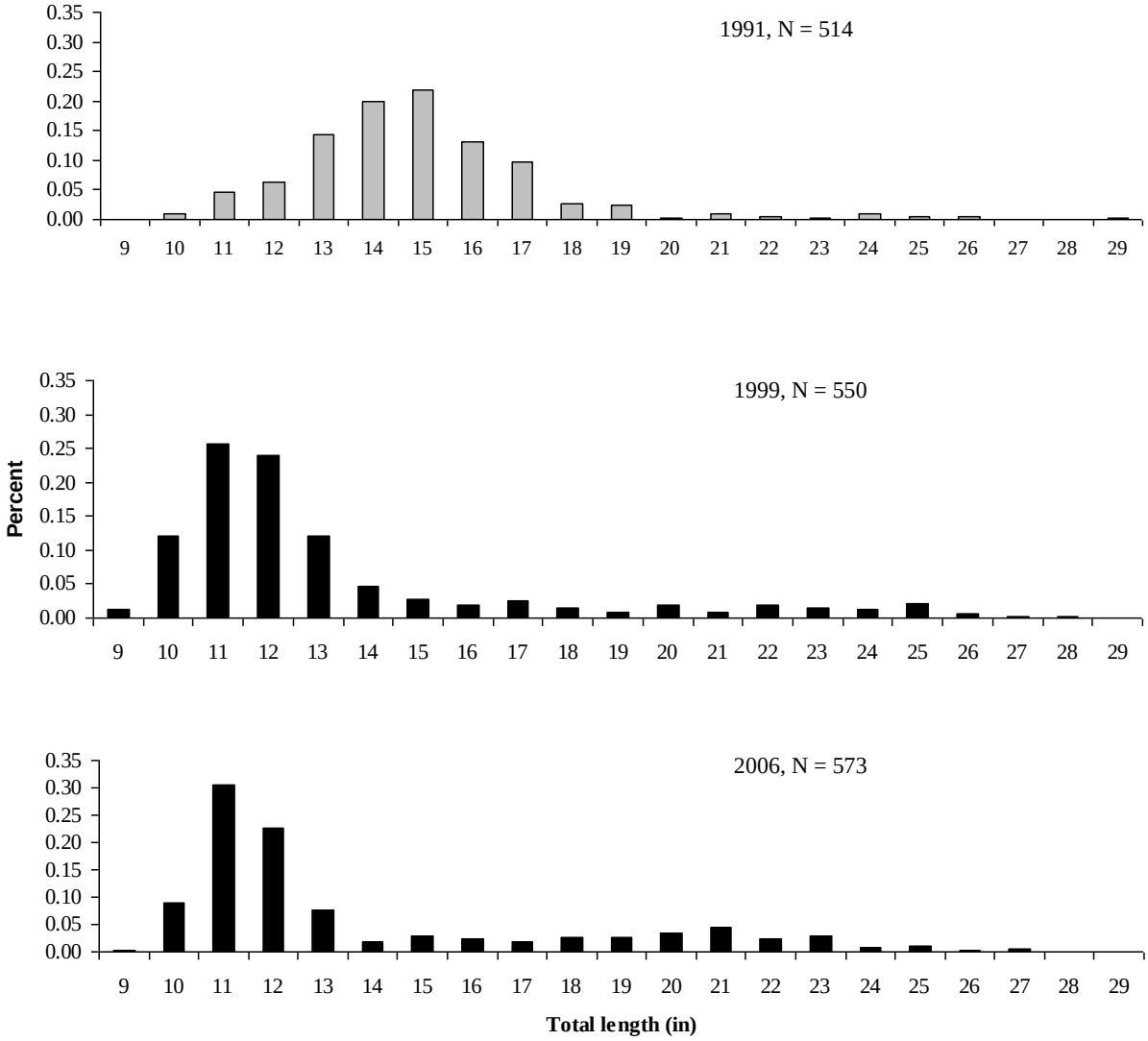

Figure 2. Percentage length frequency of spring fyke net and electroshocking catches for walleye by length interval in Amnicon Lake, Douglas County, Wisconsin. Black bars represent fyke net surveys, gray bars represent electroshocking surveys.

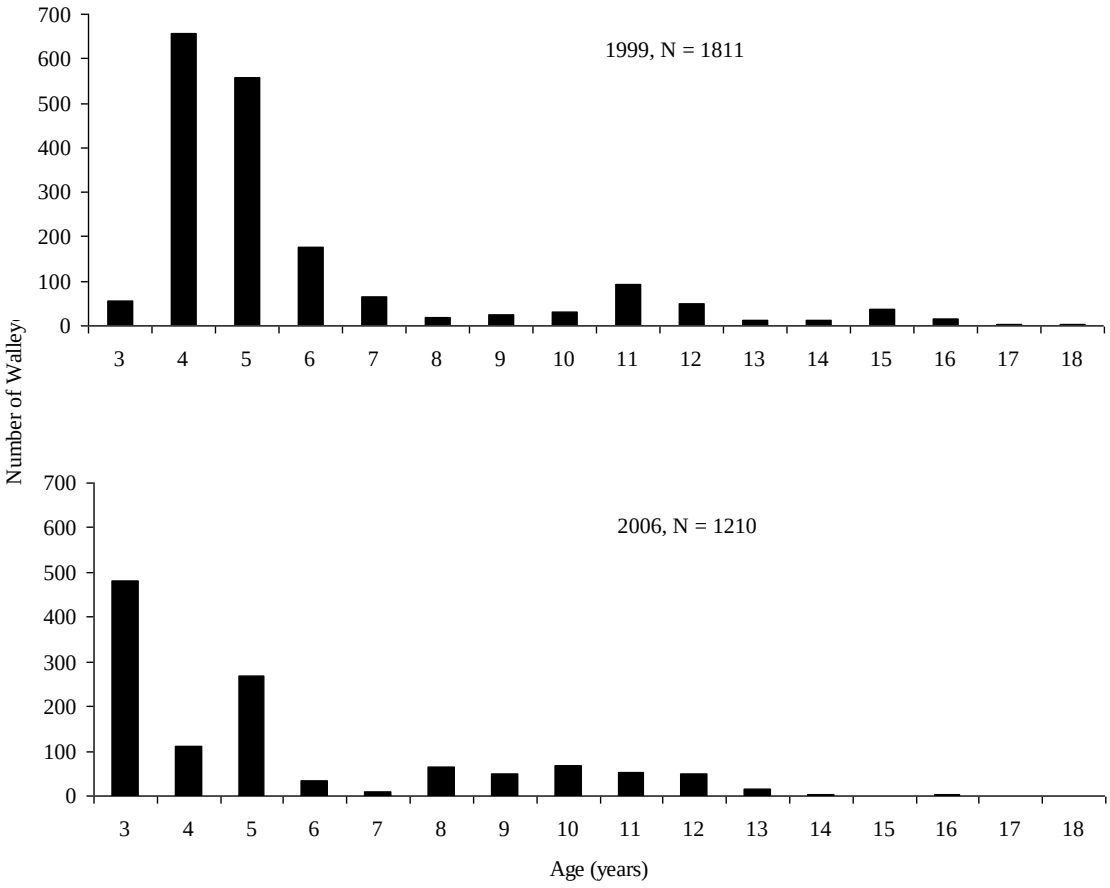

Figure 3. Age distribution of walleye expanded to adult population estimate in Amnicon Lake, Douglas County, Wisconsin.

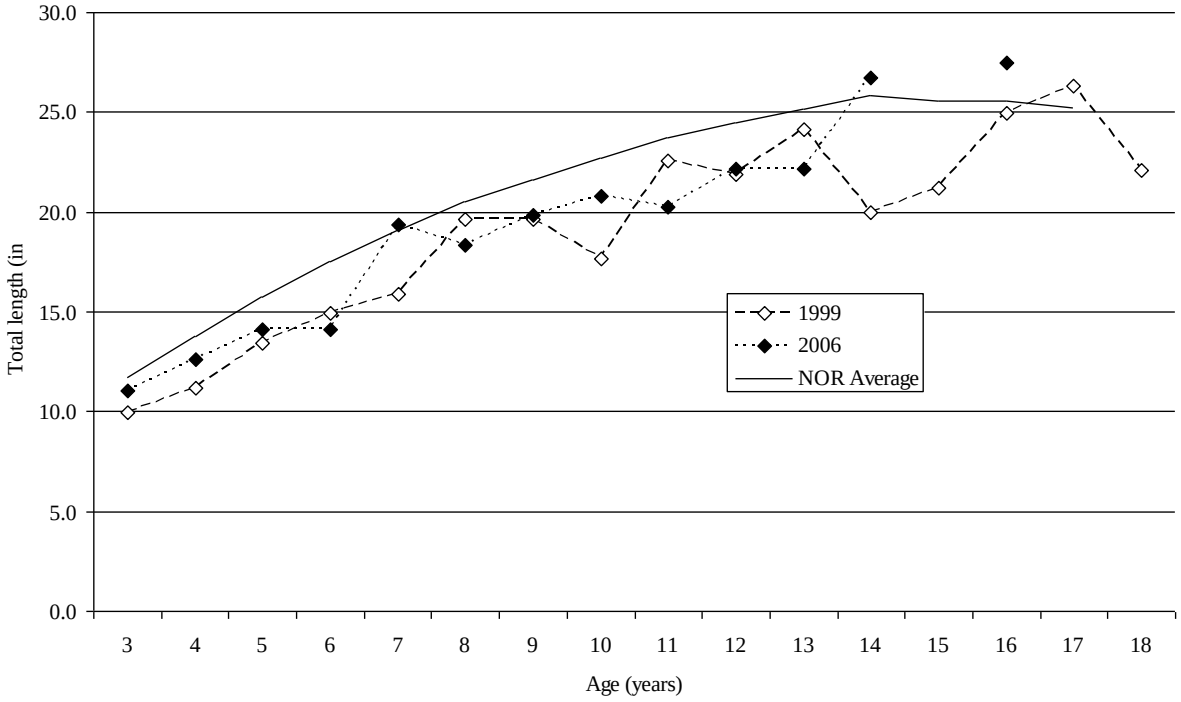

Figure 4. Age at length of walleye in Amnicon Lake, Douglas County, Wisconsin.

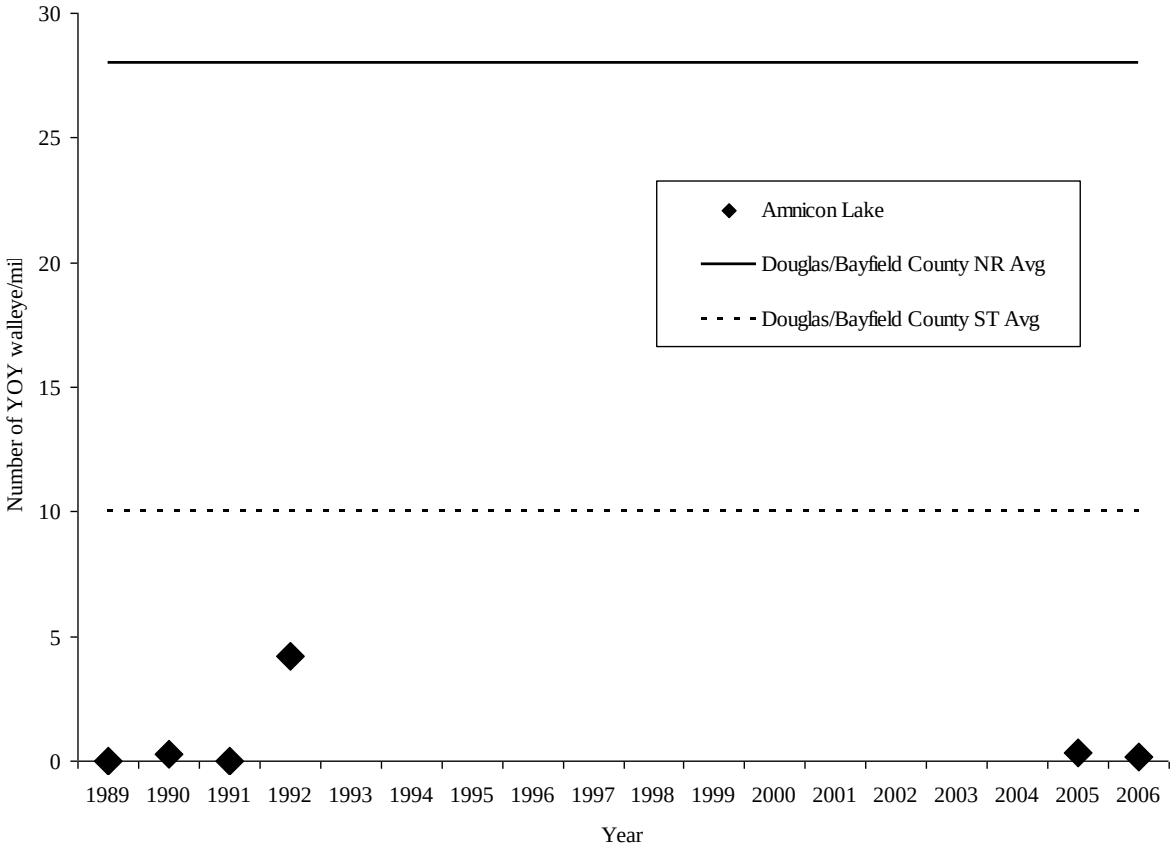

Figure 5. Young of the year walleye relative abundance determined by fall electroshocking in Amnicon Lake, Douglas County, Wisconsin. Surveys were not completed from 1993 to 2004. Solid black line represents the Douglas and Bayfield County average YOY walleye/ mile for natural recruitment (NR) lakes. The dotted black line represents the Douglas and Bayfield County average YOY walleye/mile for stocked (ST) lakes.

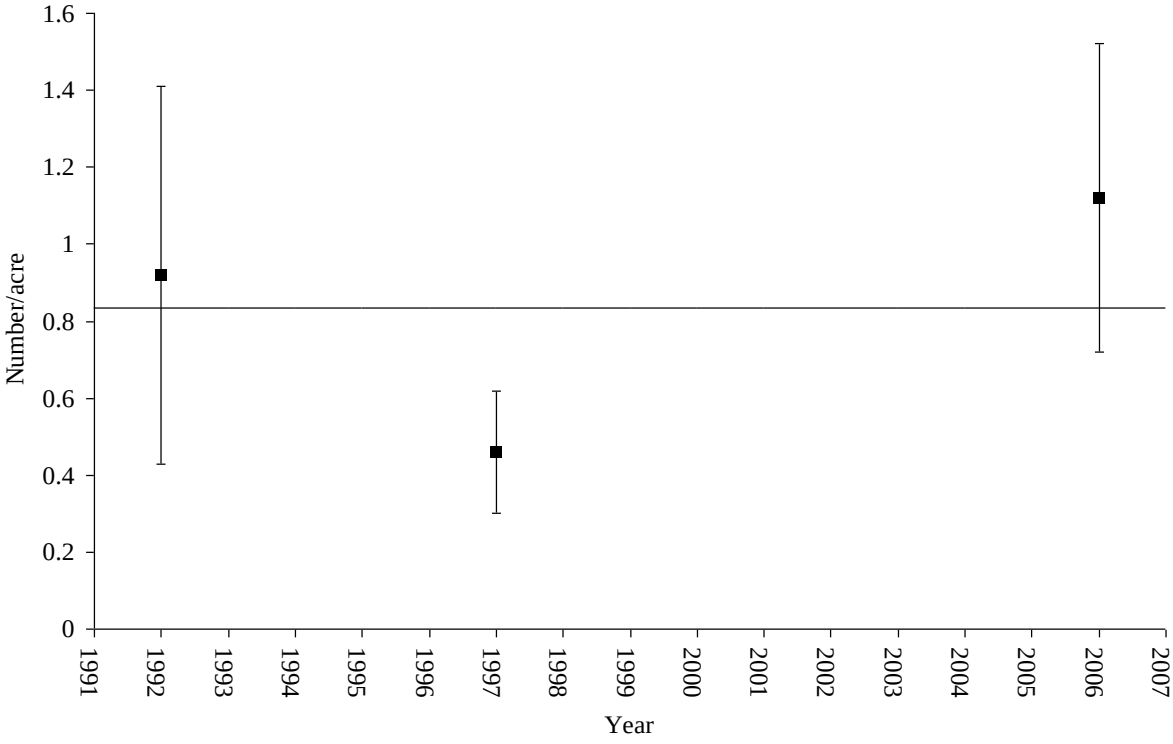

Figure 6. Number of muskellunge >30 in sexes combined (number/acre ± 95% confidence intervals) by year in Amnicon Lake, Douglas County, Wisconsin. Horizontal line represents the average of 0.8 fish/acre.

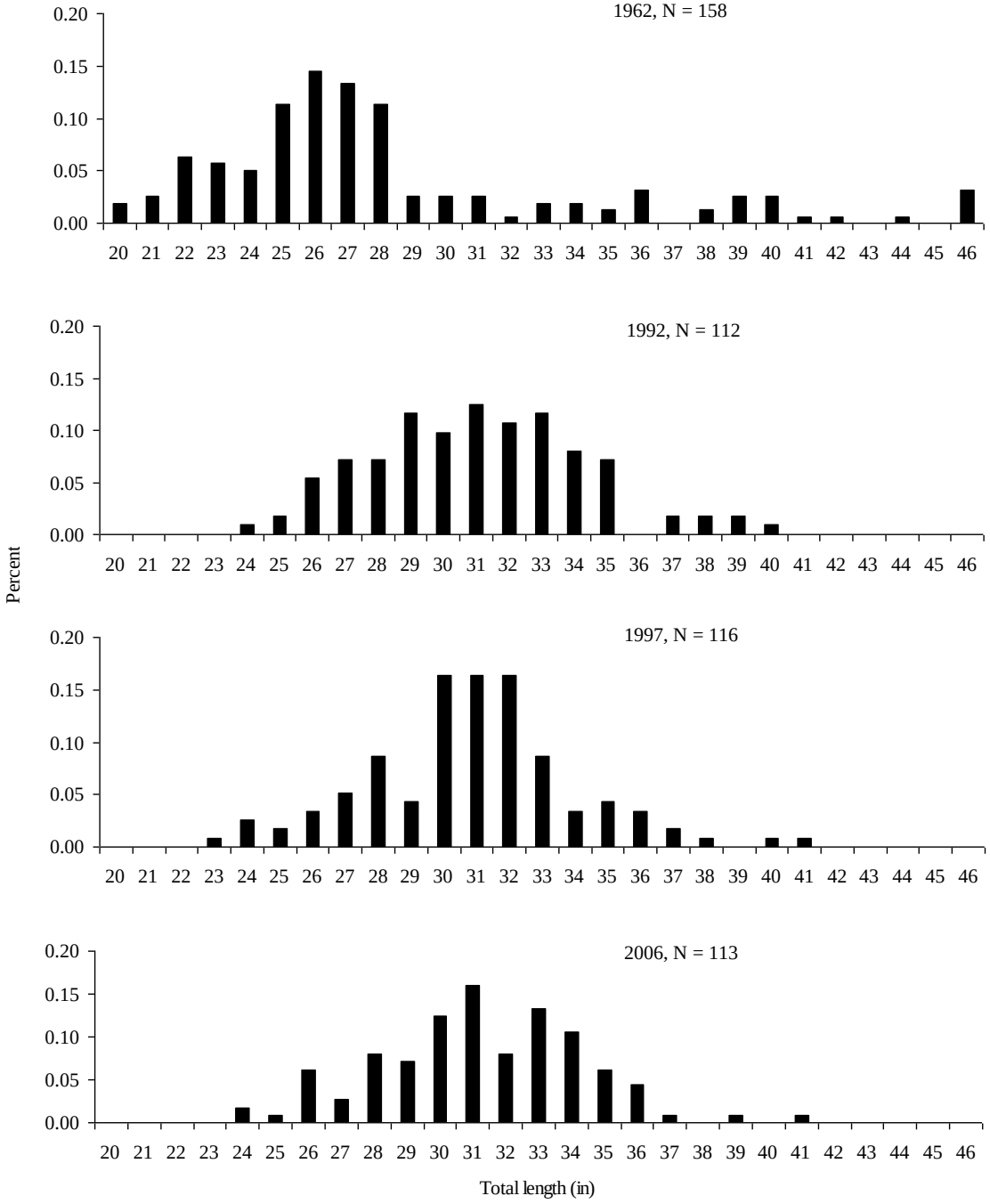

Figure 7. Percent length frequency of muskellunge in Amnicon Lake, Douglas County, Wisconsin.

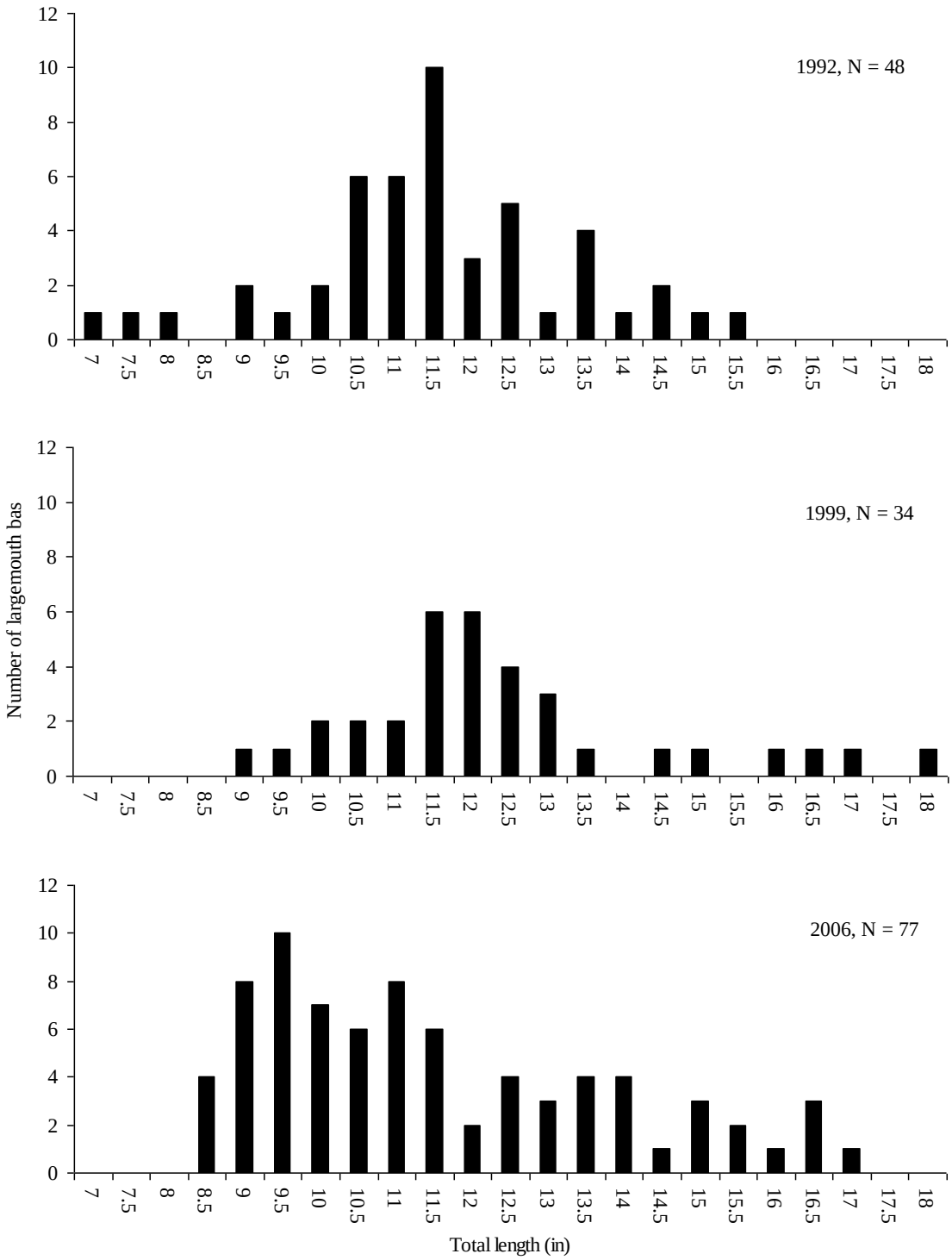

Figure 8. Length frequency of largemouth bass in Amnicon Lake, Douglas County, Wisconsin.

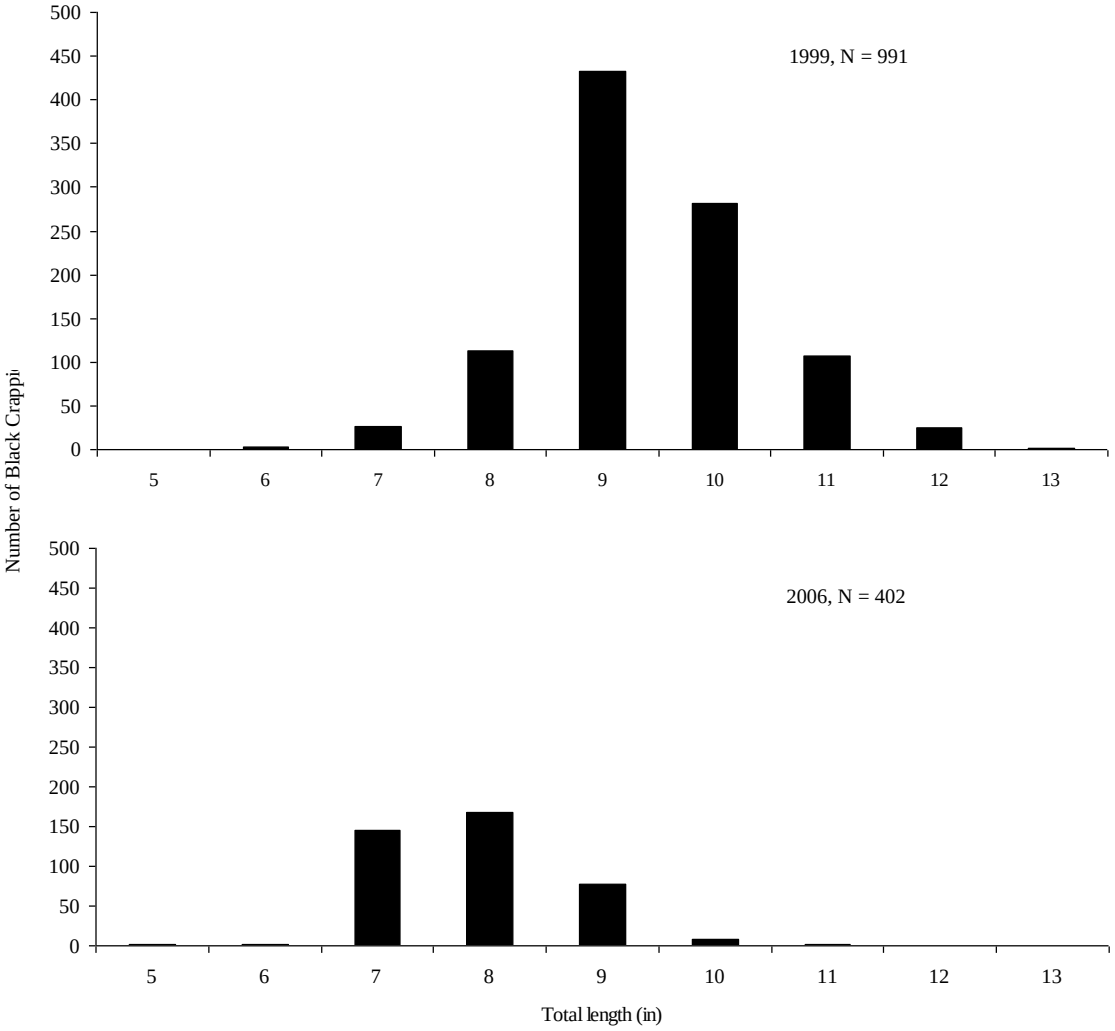

Figure 9. Length frequency of angler harvested black crappie, Amnicon Lake, Douglas County, Wisconsin.

Appendix Table 1. Proportional and relative stock density values.

Species	Stock Size (in)	Quality Size (in)	Preferred Size (in)
Black Crappie	5	8	10
Bluegill	3	6	8
Largemouth Bass	8	12	15
Northern Pike	14	21	28
Yellow Perch	5	8	10
Walleye	10	15	20